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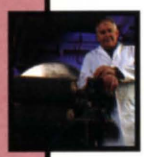

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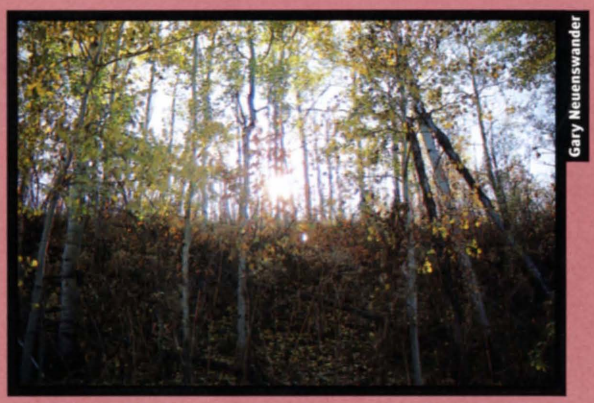

Gary Neuenswander

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UTAH SCIENCE

Study Examines Links Between Nutritional Factors and Cleft Birth Defects

Twin boys, both with clefts, raise interesting questions about the roles of genes and environment in causing these birth defects in the Philippines.

Ron Munger

Cleft lips and cleft palates are among the most common disfiguring birth defects.

In developed countries, most clefts are surgically corrected soon after birth. In many developing countries, faces and lives are often permanently disfigured.

A USU researcher is determining whether proper nutrition can reduce the incidence of these orofacial birth defects.

Nutritional epidemiologist Ron Munger works in the Philippines with Operation Smile, a private non-profit volunteer medical service organization that provides reconstructive surgery and related health care to children and young adults.

Nutrition Implicated

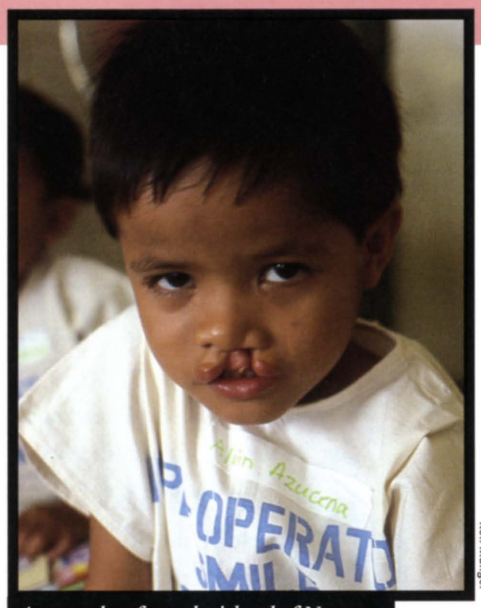
During his last visit, hundreds of Filipinos with unrepaired clefts thronged to Operation Smile for help, including many children who had traveled for days. "After a few days, it seemed unusual to see a child without a cleft," Munger says.

Munger is heartened by recent studies linking a lack of the vitamin folic acid with neural tube birth defects, such as spina bifida. Cells that give rise to the neural tube and regions of the face migrate from the same region of the embryo. He says some of these epidemiological studies were "elegant," especially a British study confirming the benefits of supplemental folic acid.

Other evidence also implicates nutritional factors in cleft defects.

In a preliminary study, Munger and colleagues from the University of Iowa College of Medicine examined 45,000 birth records in the Philippines. The

incidence of orofacial cleft birth defects was twice as high (about 2 per 1,000 births) as in America. Another pilot study examined blood samples of Filipino women who had given birth to an affected child within the last 6 years.



Ron Munger

A young boy from the island of Negros in the Central Philippines is one of the fortunate accepted for surgery.

Folate levels in the red blood cells of mothers of affected children were abnormal, evidence of deranged folate metabolism, perhaps due to a deficiency of other vitamins such as B12, which is derived largely from animal sources. The diets of many Filipinos contain little seafood, meat or dairy products.

In addition, the incidence of these orofacial cleft birth defects among Filipinos declines to "normal" levels after they have lived in the United States for several years.

Munger recently received a 3-year grant from the Thrasher Research Fund for research in the Philippines.

In his next visit to the Philippines in February, Munger and provincial health authorities will conduct a detailed dietary survey in addition to collecting and analyzing blood samples.

A Sustainable Solution

"Our goal is to document the problems, understand the mechanisms involved, and then to develop a sustainable solution," Munger says.

A food-based solution, such as bolstering the nutrient content of crops, is particularly attractive because it avoids the expense and difficulty of distributing vitamin supplements and trying to maintain intake. Furthermore, USU is uniquely positioned to take a leadership role in endeavors of this type, given its extensive experience in agricultural research, international development, and nutrition, Munger says.

It's also necessary to increase the production of animals and food crops that are rich sources of the limiting nutrients. Food scientists may be able to insert genes controlling the synthesis of vitamins into organisms that produce fermented foods such as cheese, yogurt, and kim-chee (pickled cabbage).

These are only partial solutions, however. "The grim reality in the Philippines and in many other developing countries is that a real solution depends on correcting widespread poverty and landlessness," Munger says. **KG**

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Beginning surgery on a patient.

Ron Munger

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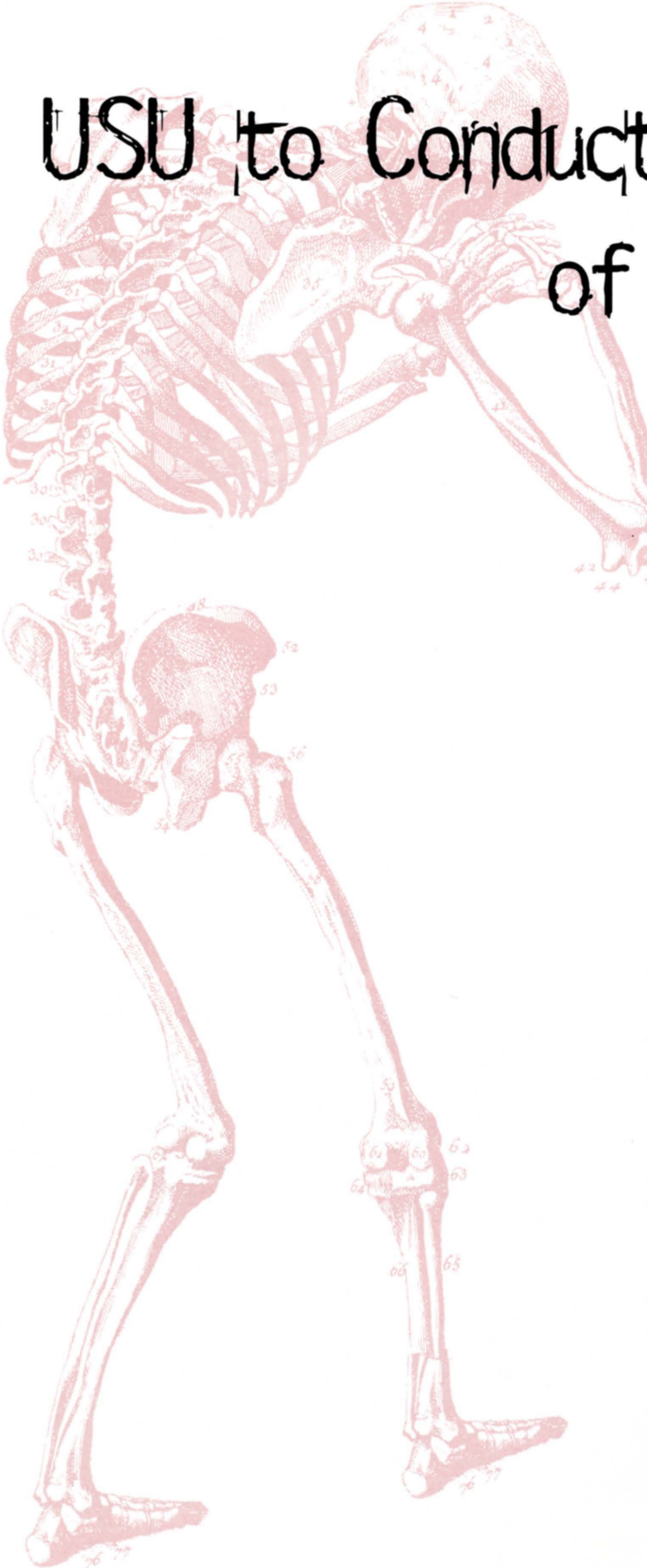
USU to Conduct Major Study of Hip Fractures



A researcher at USU heads a multi-million dollar study of the role of nutritional and genetic factors in hip fractures of elderly Utahns.

The study, which is funded by the National Institutes of Health, involves researchers from several other institutions, including the University of Utah, the University of Iowa, the Johns Hopkins University, and Brigham Young University.

Medical costs associated with osteoporotic fractures total $10-$20 billion annually in the United States; hip fractures account for most of this amount. The incidence and medical costs of hip fracture will increase dramatically as baby boomers age.

Several Factors Examined

"Most research concerning osteoporotic hip fractures and nutrition has focused solely on calcium intake even though there's evidence that other nutrients may be involved," says USU nutritional epidemiologist Ron Munger, principal investigator for the study. Genetic factors have also been implicated in osteoporosis and will be included in the Utah study.

"This is a unique opportunity to study interactions between diet and genetic factors in determining the risk of hip fractures," Munger says. Other factors related to falls that will be examined include frailty, vision problems, and the physical layout of homes.

The study will involve approximately 20 hospitals in Utah and nearly 2,000 Utah men and women at least 60

years of age who have recently suffered hip fractures, as well as a similar number of comparison participants. Participants will be asked a variety of questions about diet, exercise and other factors. Blood samples will be taken for DNA analysis.

Women 50 years of age have a one in five chance of suffering a hip fracture during the remainder of their lives. Munger says research has tended to focus on women although hip fractures are also a serious problem for men.

Post-menopausal estrogen use in women can prevent bone loss but seems to be effective only for 8-10 years after menopause. "Clearly, we need to develop other ways to prevent hip fractures in men, and in women who are 10 years past the menopause," Munger says.

The study will also involve Native Americans in east-central and southern Utah, and the Four Corners region. Differences have been noted in the incidence of hip fractures between Native Americans in different regions. **KG**

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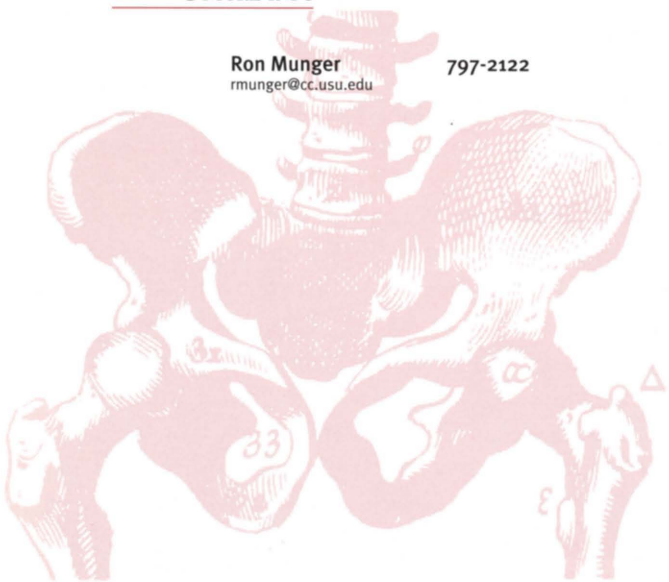

Recent Grants and Contracts

The International Irrigation Management Institute funds the creation of a world water and climatic atlas for agriculture by **Donald Jensen**, director of the Utah Climate Center (Plants, Soils & Biometeorology Department).

Keven Jackson, Animal, Dairy & Veterinary Sciences Department, is studying sanitizing materials and procedures for use on mink ranches. His research is supported by the Mink Farmers Research Foundation.

The Center for Developmental and Molecular Biology (**Kenneth White**, Animal, Dairy & Veterinary Sciences Department), the Center for Genetic Improvement of Livestock (**Noelle Cockett**, Animal, Dairy & Veterinary Sciences Department) and the Center for Value Added Seed Technology (**John Carman**, Plants, Soils & Biometeorology Department) continue to receive funding under the Centers of Excellence program of the Utah Department of Community & Economic Development.

Gary Straquadine, Agricultural Systems Technology & Education Department, is studying the development of curriculum materials concerning sustainable agriculture. His research is funded by the national FFA office.

John Carman, Plants, Soils & Biometeorology Department, studies plant regeneration with support from Lockheed Idaho Technologies Company.

Joseph Irudayaraj, Biological & Irrigation Engineering Department, is developing instructional tools for key courses in bioprocessing and food engineering with support from the Agricultural Research Service (USDA).

Recent Grants and Contracts (Continued)

Steven Aust, Chemistry & Biochemistry Department, studies iron toxicities and pathologies with funding from the National Institutes of Health (US Department of Health & Human Services).

Stephen Poe, Agricultural Systems Technology & Education Department, is developing energy-related information materials for the Utah Department of Energy, and studies manure management with funding from Cytozyme.

Christopher Barrett, Economics Department, is studying markets in the Pacific Rim for U.S. pork with funding from the National Pork Producers Association and sustainable tropical development with funding from the Pew Charitable Trusts.

Ann Austin, Family & Human Development Department, studies child care with funding from various sources, including the Utah Department of Community & Economic Development.

Dale Blahna, Forest Resources Department, is studying the economic sustainability of recreation and tourism in the canyon country region of Utah. The research is supported by the National Biological Survey (USDI).

Dale Barnard, Animal, Dairy & Veterinary Sciences Department, is characterizing drug-resistant cytomegalovirus with funding from the National Institutes of Health (US Department of Health & Human Services) and studies methods of controlling Aleutian disease in mink with funding from the Utah Department of Agriculture.

Frank Salisbury, Plants, Soils & Biometeorology Department, is developing a database for growing plants in controlled environments with support from NASA and the Johnson Space Center.

Norris Stenquist, Animal, Dairy & Veterinary Sciences Department, studies of use of ultrasound to monitor the quality of beef. The research is supported by the Utah Department of Agriculture.

Dan Drost, Plants, Soils & Biometeorology Department, studies onion production with funding from the Utah Department of Agriculture.

Mark Healey, Animal, Dairy & Veterinary Sciences Department, studies methods to control the parasite Cryptosporidium with funding from the Utah Department of Agriculture.

Esmaiel Malek, Plants, Soils & Biometeorology Department, tests atmospheric surface layer turbulence with support from the National Science Foundation.

Roger Kjelgren, Plants, Soils & Biometeorology Department, is developing educational materials concerning irrigation scheduling for turf and water management with funding from the Bureau of Reclamation (USDI).

Reed Holyoak, Animal, Dairy & Veterinary Sciences, studies the vertical transmission of scrapie in sheep with funding from the Animal & Plant Health Inspection Service (USDA).

Layne Coppock, Rangeland Resources Department, studies small ruminant production systems with funding from the University of California at Davis.

Janis Boettinger, Plants, Soils & Biometeorology Department, is analyzing soil in the Ashley National Forest (Uinta Mountains) with funding from the Forest Service (USDA).

V. Philip Rasmussen, Plants, Soils & Biometeorology Department, implements Extension training projects under the auspices of the Western region Sustainable Agriculture Research & Education (SARE) program of the Cooperative State Research, Education & Extension Service (USDA).

Device Aids Precision Irrigation

Within a few years, an extremely accurate method of measuring soil water content will probably control drip and sprinkler irrigation systems.

The relatively new system is based on the speed at which electromagnetic waves travel through a 3-pronged stainless steel fork embedded in soil. (The waves travel 80 times slower in water than in air.) The higher the water content or salinity, the slower the wave speed. Wave speed is analyzed by a device known as a cable tester, and results are sent to a computer linked to the irrigation system.

USU soil physicist Dani Or and coworkers have developed computer programs that make it easier to set up and operate such a system. (The software is available on the World Wide Web at http://tal.agsci.usu.edu).

The system, known as time domain reflectometry or TDR has been widely used in research to pinpoint areas of water uptake, determine evaporation rates from topsoil, and the amount of water that adheres to clay particles.

The system can also monitor salt transport and the passage of plumes of contaminants through soil. USU researchers rely on TDR to study salt accumulation when saline waste water from electrical power plants is applied to fields.

Or says the TDR system is the most accurate method of measuring soil water content (accurate within about 1/2 percent). It also avoids the radiation hazards associated with methods such as neutron probes. Moreover, measurements are easy to obtain and can be automated. It's also possible to monitor several sites simultaneously.

Decreases in the prices of system components are spurring commercial applications. Stand-alone probes for measurements at a single site are now available for $250-$800. A cable tester, required to measure several sites, now costs about $7,000. **KG**

Gary Neuenswander

Dani Or with the TDR system.

MORE INFO

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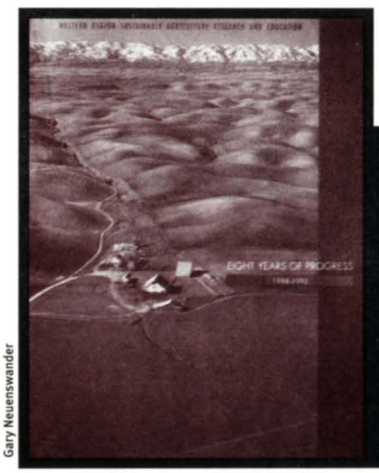
Utah Agriculture Gains from Sustainable Symphony

Sustainable agriculture is making some beautiful music in Utah, according to the coordinator of a $2.2 million sustainable agriculture project for the Western states.

One reason is that Utah State University, the host institution for the Western Sustainable Agriculture Research and Education (SARE) program, derives substantial benefits from administering the program. The other is that the efforts to nurture sustainable agriculture benefit everyone, including farmers and ranchers in Utah.

"Utah producers directly benefit from research that USU coordinates from Guam to Wyoming," says Phil Rasmussen, head of the USU Department of Plants, Soils & Biometeorology who also directs the SARE program for 13 western states and 4 island protectorates.

The program also enhances USU's reputation as a world leader in developing sustainable agricultural systems, "a real accomplishment for a relatively small state with a limited amount of cropland," he says.

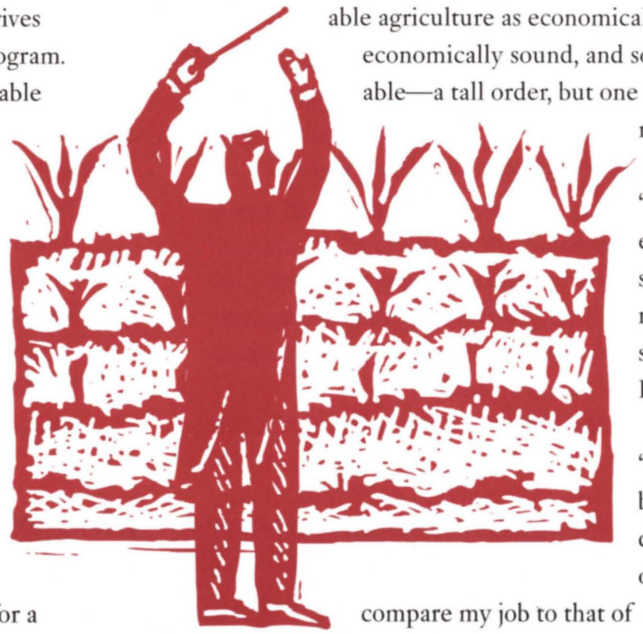


Gary Neuenswander

The 1996 report for the Western Sustainable Agriculture Research and Education Program is available from:
Western Region SARE Office
Ag. Sci. Bldg., Rm. 320
Utah State University
Logan, UT 84322-4865
tel: (801) 797-2257
fax:(801) 797-3376

A Popular Concept

Rasmussen says sustainable agriculture is a widely popular but fuzzy concept. For example, it includes but is not limited to "organic" agriculture. The project encourages participation from farmers who may otherwise be at loggerheads. He defines sustainable agriculture as economically viable, economically sound, and socially acceptable—a tall order, but one that's within reach.



"If it's not economically sound, it can never be sustainable," Rasmussen says.

"The key is to balance different definitions and objectives. I compare my job to that of a symphony conductor. We need diversity—different instruments—but they won't make any music unless they're playing in harmony," he adds.

Recent grants awarded by the program, ranging from agroforestry in Alaska to manure management in American Samoa, reflect both harmony and diversity. About a third of the projects concern livestock operations, more than half involve crops, and the rest cover rural communities, public lands and wildlife.

Examine Entire System

"We look at the whole system—people, land, and food and fiber—rather than isolated pieces," he says.

Rasmussen says the program has chalked up some major gains since its inception in 1988. Congress apparently agrees, and recently allocated more than $11 million for 1997 SARE projects nationwide.

Among the projects with tangible applications in Utah is one in Montana that increased forage yields on private land to compensate for reductions in grazing on public land, and one in New Mexico to convert land in the Conservation Reserve Program to more-productive forages using methods that prevented soil erosion.

"We're looking ahead, not only to the next century but to the next millennium," he says. A recent SARE-funded project in Utah concerned the preservation of prime farmland, an issue close to the heart of Cache Valley dairy farmer John Meikle who says the loss of farmland is like "eating our seed corn."

It's not surprising that program has been embraced by farmers and ranchers because they're the ones who plan (and often conduct) the projects. They are members of the SARE's administrative council and help plan every project. Many conduct the research. In Utah, for example, a recently SARE-funded program will help a grower of organic wheat in Box Elder County use composted manure as a source of nutrients. Organic wheat commands a premium of $2.00 per bushel.

The Western SARE program, one of four such regional projects in the U.S., is funded by the U.S. Department of Agriculture and the U.S. Environmental Protection Agency. **KG**

SARE hopes to help preserve farmland.

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HOTLINE

COOPERATIVE AGREEMENT PROVIDES MORE RESEARCH OPTIONS

The Utah Agricultural Experiment Station is participating in a cooperative research agreement with Brigham Young University, the University of Idaho, and the Agricultural Research Service (USDA).

The agreement concerns research conducted at BYU's 3,000-acre Skaggs Research Ranch located in Cassia County, Idaho, just north of the Utah border near Snowville. "The arrangement provides an opportunity to utilize facilities and expertise at each institution for research that otherwise wouldn't be possible," says H. Paul Rasmussen, director of the Utah Agricultural Experiment Station.

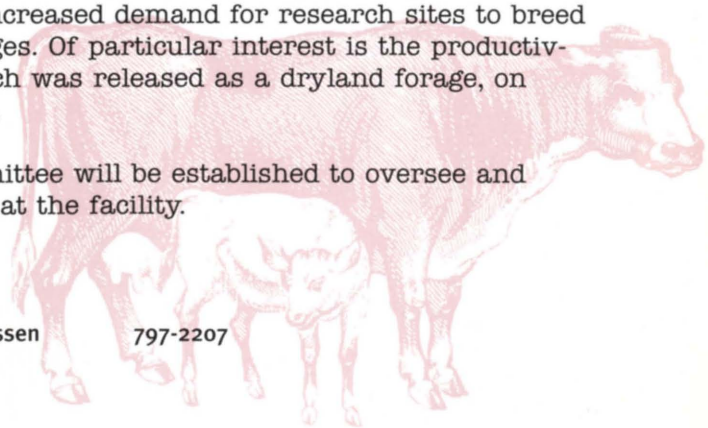
Research will focus on forages, pastures, and livestock production. One major advantage of the agreement is the ability to conduct research on a ranch scale, says USU animal scientist Randy Wiedmeier, who has already used the facility to study the response of 70 cow-calf pairs on improved irrigated pastures. Under these conditions, the average 205-day weaning weight was 725 pounds. (Under conventional conditions, a 205-day weaning weight of 500 pounds is considered satisfactory.) The study is part of a larger effort to find alternative methods of production if grazing on public lands is restricted or eliminated.

"If research was limited to USU, the study would have had only 32 cow-calf pairs," Wiedmeier says. There are also 14 center pivots at the Skaggs Research Ranch and about 600 cows on the ranch. Calves are raised under various management systems until they reach slaughter weights.

"The facility certainly offers an opportunity to conduct quality research on grazing," says USU range nutritionist Ken Olson.

Jerry Chatterton, research leader of the ARS Forage and Range Research Laboratory in Logan, says the agreement provides for the increased demand for research sites to breed and test new forages. Of particular interest is the productivity of NewHy, which was released as a dryland forage, on irrigated pastures.

An advisory committee will be established to oversee and evaluate research at the facility.



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EXPERIMENT STATION AND USDA RELEASE SQUIRRELTAIL GERMPLASM

The Utah Agricultural Experiment Station and two USDA agencies, the Natural Resources Conservation Service and the Agricultural Research Service, have jointly released germplasm of Sand Hollow squirreltail (*Elymus elymoides sensu amplo*), a native grass that promises to aid the restoration of rangelands dominated by exotic weedy annual grasses such as cheatgrass and medusahead wildrye.

Tom Jones, research plant geneticist at the USDA-Agricultural Research Service Forage and Range Research Laboratory in Logan, evaluated 37 accessions of the grass from sites in California, Colorado, Montana, Nevada, Utah, Washington and Wyoming. Sand Hollow, an accession originally collected from Gem County, Idaho, possesses superior attributes and was selected for release.

Squirreltail is a short-lived perennial that germinates readily, tolerates fire, and reaches reproductive maturity rapidly. Sand Hollow should be adapted to sandy soils throughout the Snake River Plain in southern Idaho and in adjacent regions to the south, east, and west. It greens up early in the spring, produces many reproductive tillers, and may reach a height of 20 inches.

Jones notes that this is the first time a grass germplasm has been released for immediate use by the public. Germplasm is usually used by plant breeders as a source of desirable attributes, such as disease resistance.

Release as a Selected Class of certified seed (natural track) will meet the demand for seed, which is likely to be used only for specific restoration and reclamation projects. No commercial cultivars of squirreltail have been released at this time.

Breeder seed will be available from the USDA-ARS Forage and Range Research Laboratory at Logan.

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UTAH FREE OF KARNAL BUNT

Good news for Utah wheat growers—there don't appear to be any infestations of karnal bunt (*Tilletia indica*) in the state.

A team of workers led by Sherman Thomson, USU plant pathologist, examined wheat samples from 1995 (60 samples) and 1996 (152 samples) collected by inspectors with the Utah Department of Agriculture. No karnal bunt spores were detected.

The fungus can infect all wheat and triticale. In addition to production losses, infestations would result in restrictions on exports. In 1995, the value of wheat production in Utah exceeded $32 million. There is now a quarantine on wheat from Arizona, California and Texas to prevent spread of the fungus.

The screening procedure, which requires microscopic inspection of thousands of spores from each wheat sample, is approved by the USDA's Animal and Plant Health Inspection Service (APHIS) in other states, and results are very reliable. "The only way to be absolutely sure that karnal bunt is not present is to sample wheat from every field, which is an extremely time-consuming and expensive procedure," Thomson adds.

APHIS funded the tests, which were a cooperative venture between the Utah Department of Agriculture and USU.

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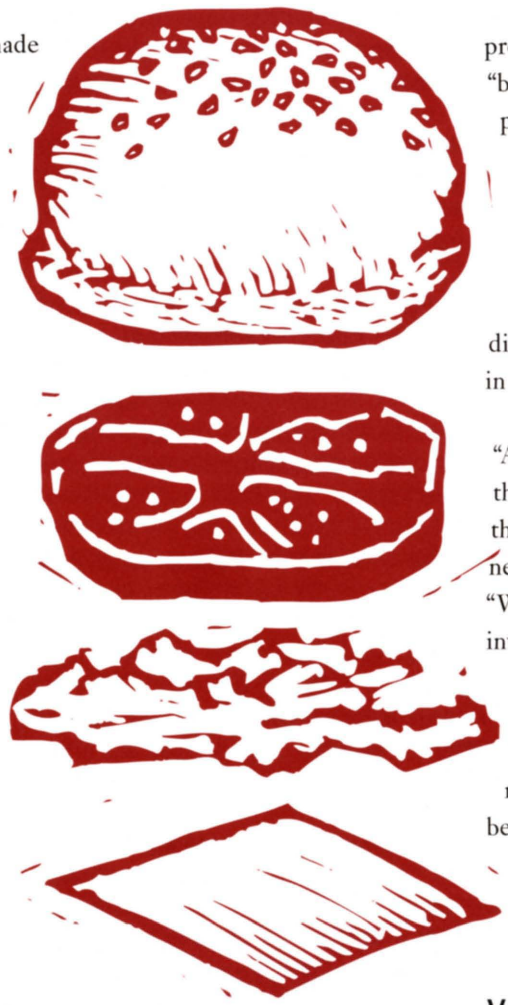
That's Fish? Baloney.

Maple- and Cajun-spiced baloney made from fish? Pâté? What's next, hamburgers?

Yes, and perhaps spreads, hot dogs, and steaks as well.

There's nothing fishy about the taste of these low-cholesterol products, all of which have been crafted from the slurry of deboned meat remaining when fish are filleted. The baloney and pate won rave reviews in taste tests, and the other fish-based products are possible with additional research, say USU scientists.

"You don't know you are eating fish," says Jeff Miller, culinary arts instructor, who was part of a team that developed the products.



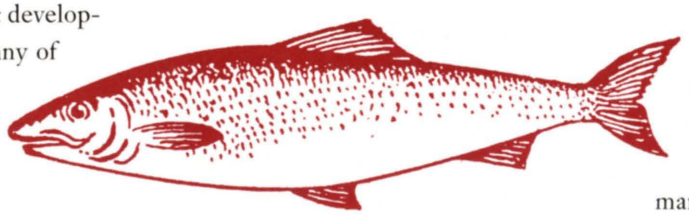
Promoting Rural Development

The project is part of USU's search for enterprises to sustain economic development in rural communities, many of which have not participated in the economic growth that has buoyed communities along the Wasatch Front.

In addition to making fish products, food engineer Conly Hansen has developed a system to transform processing wastes into fertilizer and "biogas" to heat water. A 3,000-gallon prototype of the anaerobic digester is being constructed in Wayne County. A similar system could be used to treat the other wastes that collect in trout ponds. Fish wastes degrade slowly, and disposal is becoming increasingly difficult (some counties accept the waste in landfills, others won't).

"A year ago the only potential use for these wastes was to be buried, and now there's the possibility of turning a negative into a positive," Hansen says. "We are looking for low-technology, low-investment investments that benefit local areas," says Ann Sorenson, head of the Nutrition and Food Sciences Department, who consulted with local residents, officials, and researchers before pursuing the concept. She says such cooperative ventures could be started by two or three farmers.

Value-Added Products



Utah has a relatively small trout industry (total sales were about $3.6 million in 1995) but holds a steady market share. Producers in the state are unlikely to increase their market share of trout for sport fishing and fillets. The greatest potential for expansion is in recovering more meat

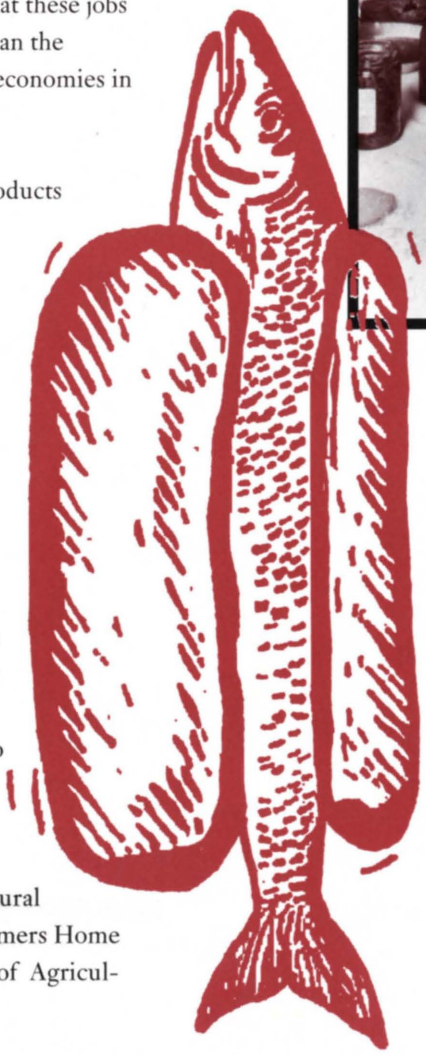
and producing value-added products, especially those tailored for niche markets on the West coast, says economist Terry Glover.

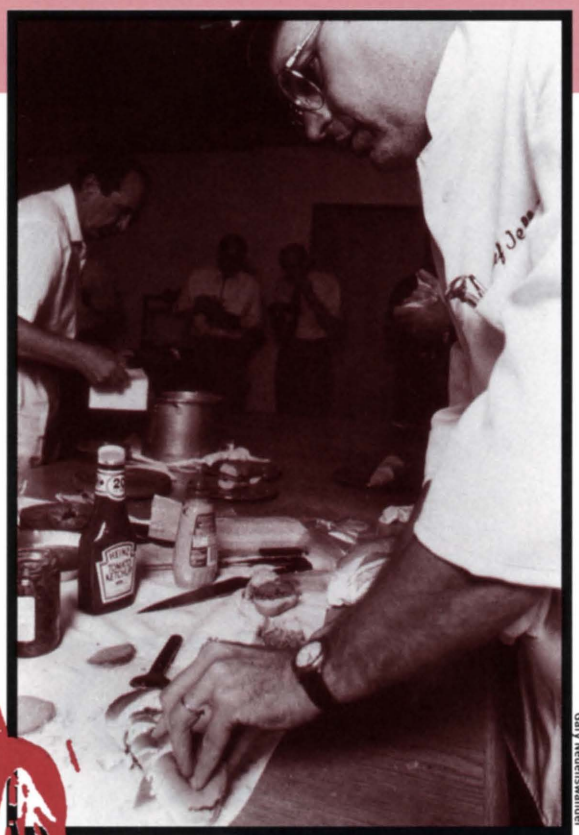
"Additional trout processing would mean more jobs in the rather remote areas of Utah outside the Wasatch Front region, such as in Wayne, Garfield, Piute and San Juan counties. More jobs would be created in processing and marketing than in actual trout farming. Our research indicates that these jobs could offer more steady employment than the construction and tourist sectors of the economies in these areas," Glover says.

The fish products are among several products developed in the Nutrition and Food Sciences Department to encourage value-added local enterprises. Others include a method of manufacturing reconstituted low-fat lamb chops, pork chops, and beef steaks suitable for microwaving or traditional cooking methods, and new starters to manufacture soft cheeses from goat or cheese milk.

Sorenson says the department is unique in its ability to handle nearly all aspects of product development, from testing attributes such as taste and mouthfeel to engineering systems for processing and waste management.

The project was funded by the USDA Rural Development Service, formerly the Farmers Home Administration. The Utah Department of Agriculture purchased fish deboning equipment. Further support and products for the research were provided by White's Trout Farm (Cache County), and the Road Creek Ranch (Wayne County). **KG**





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Slicing fish sausage for reviewers.

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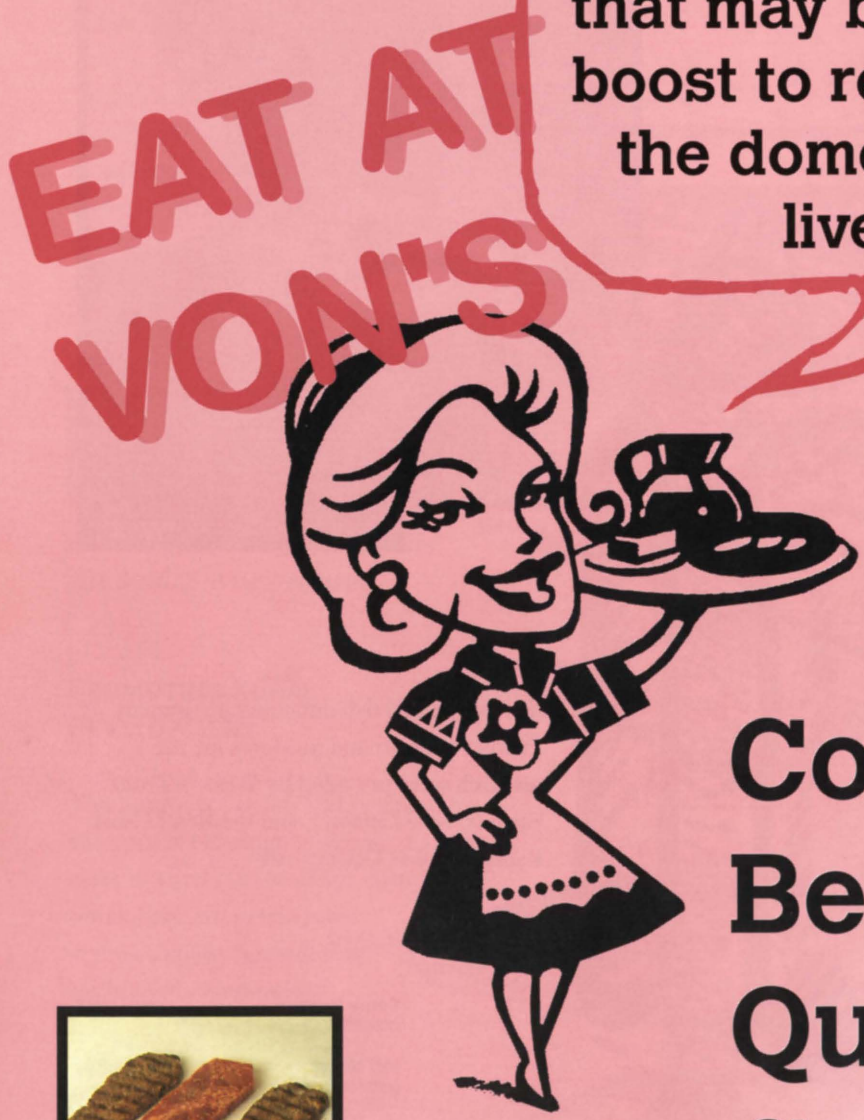
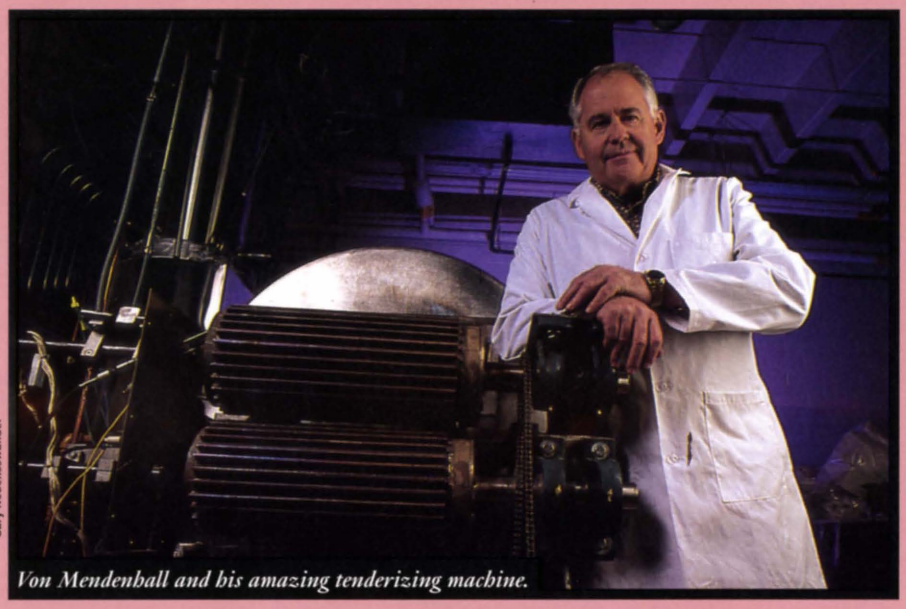
Beef steaks are about to muscle their way onto the menus of fast-food chains, thanks to a marketing innovation that may be the biggest boost to red meat since the domestication of livestock.



USU Invention Couples Beef's Quality with Convenience

An invention by USU food scientist Von Mendenhall removes the gristle, cuts the fat, and results in uniform, juicy and tender chops and steaks—quickly, and without any loss of flavor or other desirable attributes.



Gary Neuensswander

Von Mendenhall and his amazing tenderizing machine.

In the fast-food business, the only red meat product with any clout is the popular but plebeian hamburger. Steaks and other cuts of red meat often require some heavy duty carving, which doesn't mesh with our proclivity to eat on the run.

Moreover, the preparation required for steaks and chops cuts into the profit margins of fast food chains and the food-service industry with sales of almost $300 billion annually.

Quality also varies. All in all, it's been a tough sell. The risk of chewing a tough steak on a bun deters consumers who eat in their best clothes—or in public.

But all that's about to change.

Uniform Steaks

"Fifteen years ago, chicken was served only on a plate. Today, 90 percent of the restaurants in the world serve a chicken sandwich," says Lonnie Adams, chairman and CEO of the Salt Lake City-based Agri-Products Inc., which holds the license for the USU technology for North America. He predicts a similar change for steaks that are as uniform as hamburger patties.

But these steaks are definitely not hamburger. Since the steaks are made from whole muscle, they have all the desirable attributes of a whole steak, but are uniformly shaped and tender. Fast, too. The processed steaks take just 8 minutes from freezer to customer.

"It (the process) has a billion-dollar potential," says Adams. The firm has three processing plants in the U.S., and plants in Singapore, Hong Kong, and Indonesia. By limiting the number of plants, the firm reduces the chance that other firms will pirate the technology.

The process involves mechanically tenderizing chunks of meat, and binding the pieces with natural meat proteins. The steaks are created by pressing meat into stainless steel forms, in any shape—round or square, a filet or a New York strip. The meat is then seared in an oven at 1,200 degrees for 20 seconds and frozen. Grill marks add the final touch of authenticity.

The fat and cholesterol content can be reduced to levels similar to chicken and fish, which should help counter the widespread misconception that any chicken or fish product is somehow more healthful than red meat. "They give another option to a heart patient limited to a diet of chicken and fish," Mendenhall says.

Mendenhall's process works equally well with lamb and pork.

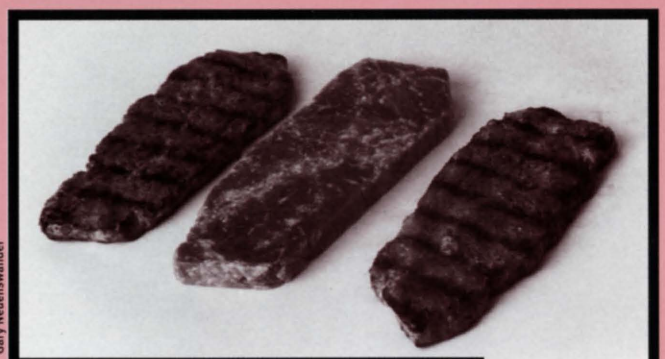
Totally Edible

"The product is totally edible—there's no fat to trim or bone to remove," Mendenhall says. "You would have to purchase 6

ounces of regular steak to get as much meat as in a 4 ounce portion of the formed steaks," Adams says.

Another advantage—the process utilizes meat from the less expensive front quarters of animals.

A 3 1/2 ounce serving of beef, pork or lamb contains about 20 grams of fat. Mendenhall's method can reduce fat content to less than 4 grams.



Gary Neuenswander

Uniformity is apparent in raw and cooked steaks.

Flavors Added

Mendenhall is also studying flavoring options such as pork that tastes like fresh pork sausage, lamb chops with the "built-in" flavor of mint jelly, and mesquite-flavored beef.

"We seldom see a steak sandwich on the menu anywhere in the United States because it's a difficult product to work with. Mendenhall's process changes that.

"There are more than 800,000 restaurants in the United States and Canada. With this process, any of these restaurants with a grill can produce a great steak sandwich," Adams says.

Adams estimates that selling the processed meat to 15,000 restaurants, each of which sold 12 steak sandwiches daily, would result in revenue of $100 million. "It should be relatively easy to reach that figure in Europe," Adams says. The license for the product in Europe is held by the Salt Lake City firm and Bakker.

Adams, who has considerable experience in the food industry, says the steaks are a "phenomenal product."

"I spent a week in the United Kingdom with distributors and called on 62 pubs. At first they were skeptical, but not after we cooked a steak and let them taste it." Sixty one of the pubs subsequently purchased the steaks.

In less than a year, since purchasing the license Agri-Products Inc. has found brokers for most of the United States and Canada, and has solved a few bugs in the production process.

Currently, three ovens are in operation, each with the capacity to produce about 1,000 pounds of meat daily. A conveyor carries the meat through an oven that is taller but about as long and wide as a refrigerator.

Other Products

Mendenhall is also studying a whole muscle product. Because the interior would remain sterile, processing at ultra-high temperatures (UHT) would pasteurize the surface without denaturing the natural muscle enzymes that tenderize meat. When packaged in carbon dioxide, the meat could be stored for 60-80 days and allowed to tenderize. Such a whole-muscle steak would be ready to eat after being microwaved for 80 seconds.

Mendenhall and USU meat scientist Charles Carpenter are also determining whether the process can tenderize meat from lambs with the inherited trait (callipyge) to produce large chops.

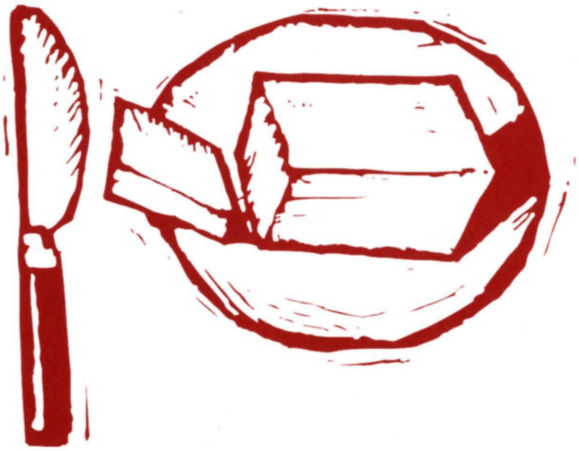
UHT processing in a gas-fired oven at a central location could reduce pollution by eliminating the smoke pollution when restaurants grill steaks and chops, Mendenhall says.

The research was supported by the Utah Department of Community and Economic Development through a Center of Excellence for Meat Processing, and the Utah Agricultural Experiment Station. **KG**

MORE INFO

Von Mendenhall **797-3463**

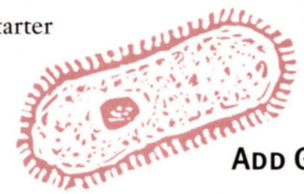
First Bioengineered Virus-Resistant Bacteria Aid Mozzarella Production



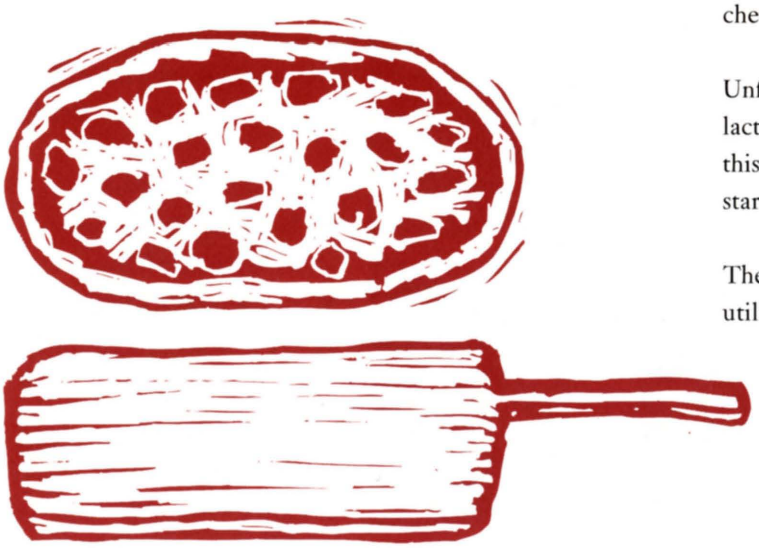
Increased mozzarella cheese production provides more opportunities for viruses to infect starter cultures and ruin entire batches of the popular pizza topping.

USU researchers developed a novel and effective solution—using biotechnology, they gave a virus-resistant bacteria the ability to ferment milk. In rotation with other conventional starter bacteria used in mozzarella production, the bioengineered bacteria provide cheesemakers with a nearly impenetrable shield against the viruses, known as bacteriophages.

Bacteriophage-caused failures of cheese cultures have cost the cheese industry millions of dollars. Starter failures in mozzarella plants increased as cheesemakers accelerate production schedules to meet demand.



Starter cultures for Italian cheese such as mozzarella usually contain two strains of bacteria, one of which (*Streptococcus thermophilus*) is particularly prone to bacteriophages. Jeffery Broadbent and Donald McMahon, food scientists at USU, and Craig Oberg, microbiologist at Weber State University, tackled the problem by screening about 30 food-grade lactic cocci to find a substitute for *Streptococcus*. A suitable strain had to tolerate relatively high temperatures and ferment milk sugars without producing gas.



Add Genes to Ferment Lactose

Pediococcus, a lactic acid bacteria important in meat and vegetable fermentation, met those requirements. (Some strains of pediococcus are already used as supplemental cultures to improve the attributes of cheddar and mozzarella.)

Unfortunately, the pediococci aren't able to ferment lactose, the main sugar in milk. The researchers solved this problem by inserting DNA from a cheddar cheese starter that contained genes for lactose fermentation.

The altered bacteria not only maintained their ability to utilize lactose, but utilized lactose faster than the original parent strain, Broadbent says. Another advantage—the pediococcus strain fermented galalactose, thereby reducing the likelihood of brown cook color in mozzarella cheese.

Bacteriophages (magnified 290,000 times) attacking cell of Streptococcus thermophilus.

Two Different Species

A particular bacteriophage usually attacks only one species of bacteria. Periodically changing starter strains usually helps prevent starter failures, but it can never be foolproof. "Because they are from a different species, our new bacteria are completely resistant to phages that attack *S. thermophilus.* If the new starter is widely used, it might be possible for phages to appear. However, we engineered two species of the pediococcus, so a phage which might appear against one species still will be unable to attack the other," Broadbent says.

"In the last 20 years, the production of mozzarella cheese has increased nearly 400 percent until it now equals cheddar cheese production of 2.5 billion pounds annually," Broadbent notes.

A First in Cheese Production

This is the first time such a starter has been engineered for cheese production. Mozzarella is a fresh cheese and particularly well suited to this approach because the starter bacteria for this cheese are not used to produce high specialized flavors, such as those associated with cheddar cheese. As a result, substituting *S. thermophilus* with pediococci has no discernible effect on the final product. Other products where these cultures may be useful include yogurt and cottage cheese, Broadbent says.

For thousands of years, cheese producers relied on the natural microflora (usually lactic acid bacteria) to serve as starters for fermentation. Because milk is refrigerated and pasteurized, cheesemakers could no longer rely on the "natural" contaminants of milk for fermentation and instead rely on carefully selected bacterial cultures. **KG**

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Student Spotlight

Sheldon Atwood is an "Aw, shucks" kind of guy, shy and self-effacing.

Don't let the mannerisms fool you. Atwood, a senior from a small town in Alberta, Canada, has already made a dent in agricultural research.

Atwood, who is majoring in Animal Science at USU, is participating in a research project with range scientist Fred Provenza concerning the effects of variety in flavor on straw consumption.

So far, the preliminary results are promising. Changing the flavor seems to boost intake, although it's too soon to say whether intake remains high over the long term. The research could have far-reaching implications. As a replacement forage, straw can cut feed costs by as much as 30 percent if intake can be maintained.

The research was prompted by Atwood's inquisitive nature.

"I was enrolled in Provenza's class, and asked some questions about what was possible, and what wasn't," Atwood says. "I guess he didn't have the answers, so we decided to find out."

This was Atwood's first "real" research experience, aside from collecting data in an ecology course. He doesn't know whether he wants to pursue a career in agricultural research, but plans to earn an MS degree under Provenza. And he's plans to continue to conduct applied research if he purchases a dryland ranch in Alberta.

Atwood grew up on his parent's 20-acre hobby farm, and worked for farmers and ranchers ever since he was a kid. He learned about USU from a friend on the football team here who "wouldn't stop talking about the school."

A good thing, too. "USU is a great school. I wouldn't have kept coming back if it wasn't," Atwood says.

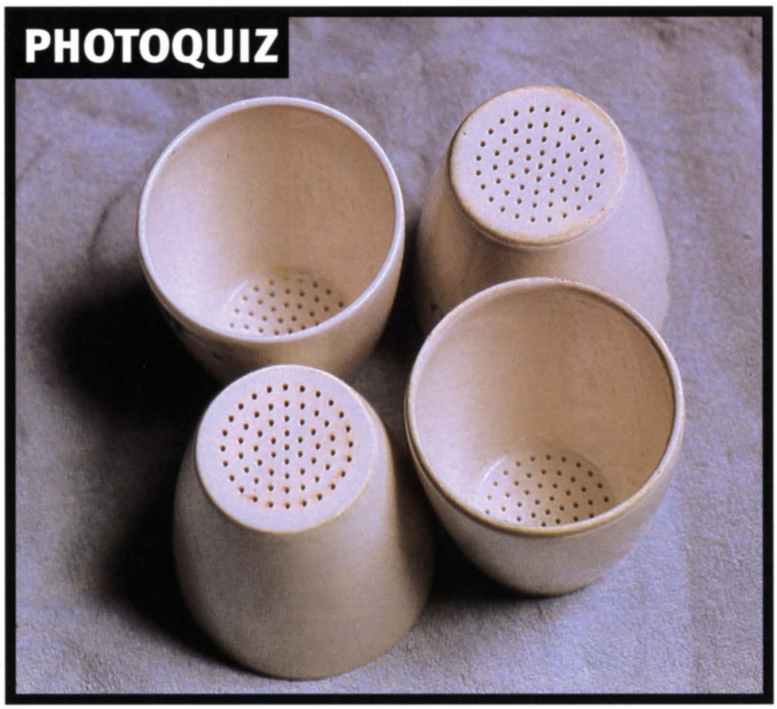
Gary Neuenswander

Sheldon Atwood

Answer to last issue's photoquiz: Cork borers, used to bore holes in cork tops of beakers, test-tubes, etc. for insertion of glass tubes.

Clue: Used in water quality analysis. Answer in next issue.

PHOTOQUIZ



Gary Neuenswander

Editor's Note

I quit.

That's it. No need to carry on about it or gush. Or complain.

I arrived a while ago, and it's about time I left. (Actually, my departure was somewhat overdue.) During my stint here, I thought I had become wiser and more perceptive, but my coworkers tell me otherwise—I just got slower. And older.

People are easily replaced, and there will be another Experiment Station editor. No harm done. It's not as if I cut such a wide swath that my absence will lead to a literary vacuum. I hope the magazine did what it was supposed to do, however.

This editorial space was a harmless refuge from the institutional perspective. A mental hiccup. Fortunately, it is tucked back here where few notice.

I am in no position to express profound thoughts about the land-grant system. However, I like what John R. Campbell says in *Reclaiming A Lost Heritage: Land-Grant and Other Higher Education Initiatives for the Twenty-First Century.* It's published by Iowa State University Press.

Check out Chapter 12, Section 3.

And, if anybody misses me—gee, thanks.

Kurt Gutknecht (KG)

Other Featured Researchers

Ron Munger

Jeff Broadbent

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